When touched these beetles dropped vertically to the ground (as is the habit of many insects) and tried to hide themselves in the fallen leaves. Some of them took to flight when they reached the ground.

On the 29th May I came across many more specimens of the same species (*P. echidna*) on the same food plant (*Z. rugosa*). At this period I also found a few in copulation.

BOMBAY NATURAL HISTORY SOCIETY,
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XXVIII.—ON THE FERTILIZATION OF THE FLOWERS OF THE SAUSAGE TREE (*KIGELIA PINNATA*, DC.) BY BATS.

(*With 3 diagrams.*)

My observations on the opening time of the flowers of the Sausage Tree (*Kigelia pinnata*, DC.) soon brought me to the conclusion that the flowers are nocturnal. They open in the evening usually between 5-30 and sunset and by about 9 a.m. the next morning, provided the flowers have been fertilized, all the corollas drop to the ground leaving only the calyx and style in position. When fertilization has not been effected the entire flower falls away from the articulation immediately below the calyx. The corollas—deep blood- or wine-red within, and yellowish-green on the outside—are large and fleshy with many wrinkles and furrows. When open, the flowers emit a strong and somewhat unpleasant odour. The four stamens are placed in the manner characteristic of the order *Bignoniaceæ*, to which this species belongs. The bases of the filaments are much thickened and are densely papillose within the throat of the flower; together with the style, these swollen bases fill up the entrance to the throat. The style is long, tapering from the base upwards; it is somewhat recurved and exerted beyond the corolla. The stigma is bifid and appears like two leaf-like structures at the extremity of the style. At the base of the ovary are situated several large nectar glands which secrete a copious

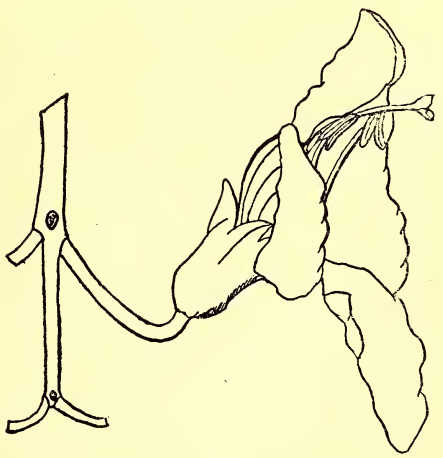

FIG. 1. Position of flower of *Kigelia pinnata*. (Half nat. size).

amount of clear sweetish nectar. This liquid fills up the cavity between the nectaries and the throat of the flower and trickles out into the furrows of the lower petal when the flower is bent downwards.

It appears curious that such a deep-red coloured flower should be adapted for nocturnal fertilization. In passing, it might be mentioned however, that similarly dark-coloured flowers also nocturnal in habit has been observed by me in the case of *Oroxylum indicum,* Vent. a common species on the island of Salsette, and belonging to the same natural order. In this case also I find that the flowers only open in the evening and are shed by the next morning, making it next to impossible to obtain a photograph of the tree in flower without the aid of a flash-light. On the other hand, I consider it noteworthy that *Heterophragma Roxburghii.* DC. and *Stereospermum xylocarpum,* Wight, also belonging to the same order and both fairly common in the same locality (Salsette) have creamy-white flowers ("night-coloured") which open only during the daylight hours! It was not until I accidentally observed a bat visiting one of the Kigelia flowers that I was led to investigate the matter further. Many of the *Bignoniaceæ* are said to be fertilized through the agency of birds, though in the case of a species like *Oroxylum indicum,* Vent. this process appears to me hardly applicable since most birds are already on their way to roost by the time the flowers open. An examination of the Kigelia flowers which opened early in the evening showed that the anthers were not yet ready to disperse their pollen, whereas those examined at dusk had the anthers perfectly ripe and the pollen ready for despersal. The slightest jerk to the flower caused the pollen to drop down directly on to the lower petal. The fact, therefore, of the pollen only becoming ready for dispersal at dusk does away with the possibility of fertilization by birds, at least the diurnal ones.

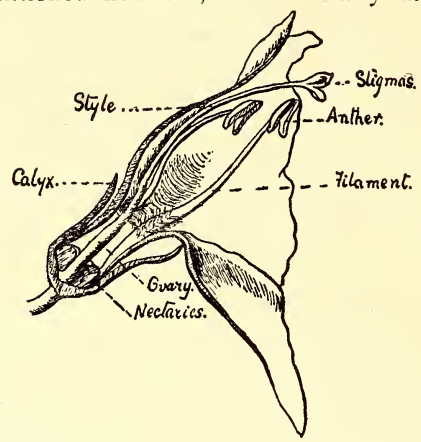

FIG. 2. Longitudinal section of the flower of *Kigelia pinnata.* (Half nat. size).

The nectar is produced in such large quantities that one literally gets a shower bath when plucking an inflorescence since, as has already been mentioned, it trickles freely into the furrows of the lower petal when the flower is bent down.

There are two avenues planted entirely with *Kigelia pinnata* trees not far from where I reside, in Gell Street and Club Back Road (Agripada). In the flowering season, March-July[1] I frequently visit-

[1] I have seen flowers and buds on certain trees as late as the end of August and early September.

ed these roadside trees at different times of the day and night to study more about the fertilization of their flowers. I noticed that at dusk the avenues were regularly visited by numbers of the Short-nosed Fruit Bat (*Cynopterus sphinx*) and was not a little surprised to discover that these animals were really responsible for the fertilization of the flowers. On several occasions I observed the bats visiting the open flowers, thrusting their heads into them and after hanging there a short while, flying off again. The bats are no doubt apprised of the open flowers by the strong smell they emit, as they were seen to circle round and round the trees before alighting. When the bat alights, the flower stalk, which is sharply bent upwards in its upper quarter, is deflexed by the weight of the animal and at the same time the peduncle of the flower swings, causing the nectar to ooze out on to the petal from where it is greedily licked up by the bat. In all probability at the time of the bat's impact with the flower the ripe pollen is shed on to the head of the bat as it is being inserted within, though there is also another possibility in that the head or ears of the visitor may actually come in contact with the anthers. There is yet the further possibility that as the bat throws its head back when taking to flight (as is its habit) the snout may come in contact with the anthers. Whatever be the exact manner in which the pollen is transferred to the fur, I think there is good ground for assuming that the head or snout of the bat or both, does get covered with pollen. When the bat's head is inside the flower the stigmas protrude over and directly behind it and in a position where the pollen-besmeared snout or crown must unavoidably brush past them when the animal takes to wing again, thus effecting pollenization. Assuming that the bat has been visiting other flowers previously and that its head has become covered with the pollen from these, there are two possible ways in which it may be transferred to the stigmas: (*a*) while entering the flower the head may come in contact with the stigmas, or (*b*) the impact and weight of the alighting bat which causes the flower to sway violently up and down may bring the stigmas into contact with the bat's head. Both these possibilities may indeed even operate simultaneously, but there seems to me no doubt that this bat is in a large measure responsible for the fertilization of the flowers of this tree. I realize that for conclusive

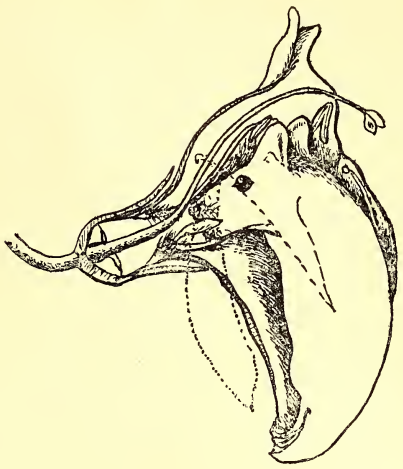

FIG. 3. Position of bat in flower. (*Drawn from memory*).

evidence it would be necessary to shoot the visiting bats for examination, but unfortunately in the present case I am unable to do so owing to the proximity of dwelling houses and the Police Regulations.

My thanks are due to my friend Mr. Salim Ali for reading over this note and drawing my attention to two important papers by Dr. Otto Porsch of Vienna[1] who has in recent years made some most valuable contributions to our knowledge on the subject of the fertilization of flowers by birds and mammals.

According to Porsch, Hubert Winkler was the first to point out from the shape and size and other peculiarities of the flowers of a closely related species, *Kigelia africana,* Benth. that this may be of bat-fertilized species although he was unable to record the visits of bats by direct observation. Porsch's own observations on *K. pinnata,* DC., in the Buitenzorg Gardens, Java, convinced him that the flowers of this tree were fertilized by bats. In regard to another closely allied species, *Kigelia æthiopica,* Decne., Porsch was also struck by the nocturnal habit of the flowers, their characteristic smell, their unusual colours and the width of the opening of the corolla. The fallen flowers under the tree showed the tooth-marks of bats and the fact that the flowers could be available to birds only for a very short time in the early morning hours, precluded the possibility of their (birds) being important pollinating agents.

Heide, who also made observations on *K. æthiopica* in the Dutch East Indies, was of opinion that the bat *Eonycteris spelaea* Dobs. which was the pollinating agent he observed, was attracted to the flowers solely by the pollen which it gathered from the anthers by means of its specially adapted rasp-like tongue. On the tongue and snout as well as inside the stomach and intestines of a specimen he shot, were found only pollen without any traces of petals or other parts of the flowers. He makes no mention whatsoever of nectar being sought, but as Porsch points out, if pollen was the bat's sole quest it is unintelligible why the visitor should thrust its head so deep down into the flowers, as has also been observed by me, and he himself is inclined to the belief that nectar is the bat's main objective.

L. V. D. Pijil, without being aware of Heide's work has independently corroborated the latter's observations in regard to the visits of bats to the flowers of *K. æthiopica.* This observer also refers to the nocturnal habit of the flowers and to their characteristic smell, but according to him likewise the chief object of the bats' visits is the pollen though he admits that at the same time nectar may be eaten.

Spennemann has observed that carrion-smelling flowers of *Oroxylum indicum* (L.) Vent. to be visited and fertilized by bats, and my note helps to confirm his remark that the flowers open in the

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[1] Porsch, Otto. 'Blütenstände als Vogelblumen', Österreichische botanische Zeitschrift, 1923, Nr. 6-8, pp. 125-149.

[2] Porsch, Otto. *'Crescentia*—eine Fledermausblume', Öst. bot. Zeitschrift, Heft 1, Jahrg. 80, pp. 31-44.